

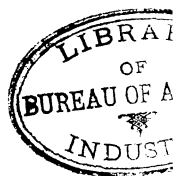
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U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY.—Circular No. 79.

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THE TUBERCULIN TEST FOR TUBERCULOSIS.

BY

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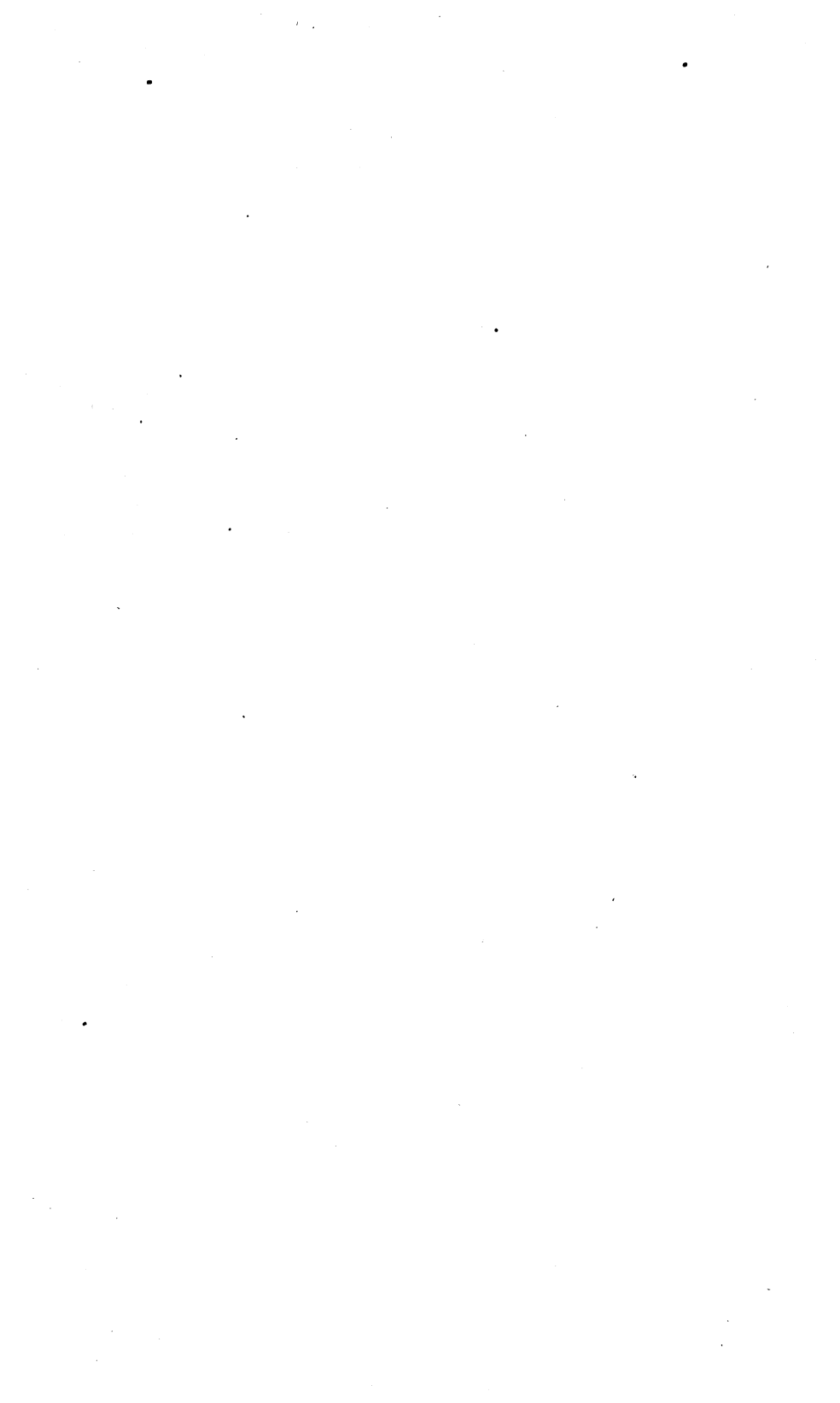
Chief of the Bureau of Animal Industry.

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By D. E. SALMON, D. V. M.,
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IMMUNITY BY INOCULATION WITH BACTERIAL PRODUCTS.

In 1882 the writer became convinced from the experimental evidence at his command that certain disease germs produced a chemical substance during their growth and multiplication which, if injected into the tissues of an animal, would induce immunity from the disease that these germs cause. In other words, he thought that the liquids in which the bacteria were grown in the laboratory might be used after the bacteria were killed or removed to protect animals from the disease caused by these specific bacteria. The experiments made at that time with the fowl-cholera microbe failed to confirm this theory, but later experiments with the hog-cholera bacillus gave unmistakable proof of its correctness. These results were first published in 1886,¹ and additional evidence was published the following year.²

IMPORTANT RESULTS OF THE STUDY OF IMMUNITY.

The demonstration of this new principle in pathology led to numerous efforts to apply it in practice and to renewed activity in the study of the general subject of immunity by the various laboratories of the world. The result has been the extraordinary development of knowledge of the toxins and antitoxins, and the application of these substances to the prevention and cure of disease. Koch took up the study of the tubercle bacillus from this point of view and experimented with the culture media in which it had been grown. The high hopes which were raised all over the world by the announcement of the discovery by him of a substance which would act as a specific for tuberculosis are well remembered, as is also the keen disappointment which followed the practical tests of the new remedy.

Koch observed that the administration of tuberculin caused an elevation of temperature in persons affected with tuberculosis, and he found it an extremely valuable means of recognizing the disease in the early stages before bacilli appeared in the sputum and before any information could be obtained by physical examination.

¹ Second Annual Report, Bureau of Animal Industry, p. 219.

² Third Annual Report, Bureau of Animal Industry, p. 50.

This discovery at once became of interest to veterinarians, who had long been embarrassed by the great difficulty of detecting tuberculosis in cattle. The diagnosis of this disease was often uncertain, even when the lungs were badly affected; but when it was confined to the glands of the chest or to the organs of the abdominal cavity its presence in the great majority of cases was not even suspected during the life of the animal. The value of tuberculin for this purpose was tested during the years 1890 and 1891 by Guttman, Roeckl and Schütz, Bang and Salomonsen, Lydin, Jöhne and Siedamgrotzky, Nocard, and many others. It was at once recognized as a most remarkable and accurate method of detecting tuberculosis even in the early stages and when the disease had yet made but little progress.

TUBERCULIN TEST IN PRACTICE.

The tuberculin test came into existence through the most careful and thorough scientific experimentation. In practice it is applied by first taking the temperature of the animal to be tested, at intervals of about two hours, a sufficient number of times to establish the normal temperature of the body under the ordinary conditions of life. The proper dose of tuberculin is then injected under the skin with a hypodermic syringe. The injection is generally made late in the evening, and the temperature is taken every two hours the following day, beginning early in the morning and continuing until late in the evening, if the fullest information is desired. From average temperatures calculated by de Schweinitz in 1896 of about 1,600 tests of tuberculous cows, it appears that in general the rise of temperature begins from five and one-half to six hours after the tuberculin is injected, reaches its greatest height from the sixteenth to the twentieth hours, and then gradually declines, reaching the normal again by the twenty-eighth hour.

A certain number of errors in diagnosis were, however, recorded in these early experiments which raised some question as to whether tuberculin was sufficiently accurate for universal adoption in the examination of cattle for this disease. The failures were of two kinds. A small percentage of the animals which showed an elevation of temperature were apparently free from signs of tuberculosis when examined after slaughter, and about an equal proportion failed to react, which upon slaughter proved to be diseased. Subsequent investigation showed, however, that the supposed errors might be largely reduced, first, by not recognizing any elevation of temperature less than 2° F. as a reaction; second, by requiring that the temperature should go to about 104° F.; third, by taking into account the tuberculin curve of the chart; fourth, by giving a sufficient dose of tuberculin; and, fifth, by making a more careful search through the carcass after slaughter for signs of the disease. The diseased animals which

failed to react were found to be either in an advanced stage of the disease (and this was easily recognizable by other means), or the disease had become arrested, and for the time being did not affect the system of the animal.

EFFICACY OF THE TUBERCULIN TEST.

In 1898, Bang, of Copenhagen, one of the highest European authorities, in his paper presented to the Congress for the Study of Human and Animal Tuberculosis, at Paris, said:

Numerous tests made in almost every civilized country have demonstrated that in the majority of cases tuberculin is an excellent means for diagnosing the existence or the nonexistence of the disease, but giving us no positive information as to the extent to which the disease has progressed. When tuberculin produces a typical reaction we may be almost sure that there exists in the body of the animal a tubercular process. The cases in which a careful examiner has not succeeded in finding it are very rare; and I am led to believe that when, notwithstanding all the pains taken, it has escaped discovery, the reason is that it is located in a portion of the body that is particularly inaccessible. Nevertheless, it is not to be denied that a fever, entirely accidental and of short duration, may in some rare cases have simulated a reaction. However this may be, the error committed in wrongly condemning an occasional animal for tuberculosis is of no practical consequence.

A worse aspect of the case is that there are some diseased animals in which tuberculin fails to discover the existence of tuberculosis. In most of these, no doubt, the deposits are old, insignificant, and generally calcified, or they are cases where the disease is arrested and perhaps in process of recovery, and which are possibly incapable of disseminating the contagion. But it is known that there are cases, not altogether rare, where tuberculin fails to cause a reaction in a highly tuberculous animal, and consequently one in which the disease exists in an extremely contagious form. For this reason a clinical examination should always be made of an animal which does not give a reaction, but which shows symptoms indicating that notwithstanding the test it may suffer from tuberculosis.

Nocard, of Paris, wrote, also, in 1898, as follows:

The degree of certainty of the indications furnished may be stated in precise terms. *The observation of a clear reaction to tuberculin is unequivocal; the animal is tuberculous.* The pretended errors imputed to the method are explained by the extreme sensitiveness of the reagent, which is capable of detecting the smallest lesion. It often requires prolonged and minute researches in the depths of all the tissues to discover the few miliary centers, the presence of which has been revealed. The reaction is absolutely specific. In those cases where it is observed, with animals which show lesions of another disease (actinomycosis, hydatid disease, verminous bronchitis, distomatosis), it may be affirmed that there exists, in addition to these conspicuous changes, a tuberculous center which alone has provoked the reaction.

The failure to react does not necessarily imply absence of tuberculosis. Such failures of tuberculin are very exceptional. They are seen most frequently with animals affected with tuberculosis in a very advanced stage and made evident by plain external signs. Sometimes, also, there are found at the post-mortem examination of animals which have not reacted small fibrous or calcified lesions in such a condition that one is tempted to believe them cured. Whether sterile or not, these lesions have no tendency to increase and they are not very dangerous from the point of view of contagion.¹

¹ Les Maladies Microbiennes des Animaux, p. 606.

These opinions of two eminent authorities, living in different countries, after long experience of their own and after studying the results of the many tests made in different parts of the world, should have great weight; they coincide throughout and are essentially the same. A similar conclusion was reached from experiments made in the Bureau of Animal Industry in 1893. In the extensively diseased herd of the Washington Soldiers' Home, 60 animals were tested, all of which were afterwards slaughtered and carefully examined. Of the 60 animals tested, 49 reacted and 11 failed to react. Tuberculous lesions were found in 48 of the animals which reacted. Five animals which did not react were also found to be diseased. One of these had a high temperature (103.6° F.) the day before the test, and this animal had extensive tuberculosis. The disease had been recognized in this animal from external appearance, and it had been isolated from the herd for from fifteen to eighteen months. Three other animals which did not react were in all probability stationary cases of disease; the nodules were small and largely calcareous. In the remaining animal which failed to react, the lesions were also small and apparently confined to the glands.

In 1897 Voges compiled statistics of tuberculin tests, the accuracy of which had been determined by post-mortem examination. Of 7,327 animals tested, it appeared that errors had been made with 204, or 2.78 per cent.¹ In the work of the Pennsylvania Live Stock Sanitary Board, post-mortem examinations were made on about 4,400 reacting cattle, and the disease was found in all but 8 of those which had given characteristic reactions.

The results of a much larger number of tests might be compiled at this time, but they would not materially change the average of those already mentioned. It is plain that tuberculin is a remarkably accurate test of tuberculosis; that the animals which react may be safely considered as tuberculous; and that when a careful clinical examination is practiced in addition to the test, there are few animals in a dangerous condition which escape detection.

IS TUBERCULIN INFALLIBLE?

The first questions asked by those who oppose the adoption of the tuberculin test are, Is this test infallible? and, If it is not infallible, why should it be forced upon the cattle owners of the country?

In answer to these questions it may be said that tuberculin is not absolutely infallible, and yet it is by far the best method of diagnosing tuberculosis that has been discovered. It is much better than any test known for pleuropneumonia when that disease was eradicated.

¹ Voges. Der Kampf gegen die Tuberkulose des Rindviehs. Jena, 1897, pp. 14 and 15.

Practically all the animals which react are affected with tuberculosis, and should be separated from the herd, not only in the interest of the public, but in the interest of the owner of the herd. The best authorities admit, after studying many thousands of tests, that there are few if any mistakes made in condemning cattle which show a typical tuberculin reaction. The errors are principally in the other direction, that is, some tuberculous animals are not discovered by the tuberculin test; but as the most dangerous of these may be picked out by ordinary clinical examination, this fault of tuberculin is not so serious as it at first sight appears. This being the case, it should not be necessary to force the tuberculin test upon cattle owners. They should be anxious to adopt it in their own interests and for the protection of their patrons. There is to-day no greater danger to the cattle and swine industries than that which confronts them in the form of tuberculosis, a disease already widespread and rapidly extending. Without the use of tuberculin it would be impossible to control this disease, and the farmer and stock raiser would be at its mercy. With tuberculin its control is not a difficult matter, and badly affected herds may be converted into healthy herds in a few years, and without very serious loss or hardship. Tuberculin is, therefore, a great boon to the farmer—one of the most beneficial scientific discoveries of modern times.

Many cattle owners have been prejudiced against the tuberculin test by incorrect or greatly exaggerated statements as to damage caused to cattle by the injection of tuberculin. Some of these statements have been based upon attacks of illness in no way connected with the tuberculin test. It was, for example, widely published that a valuable Short-horn bull was seriously damaged in the Garfield quarantine station by being tested for tuberculosis. The facts are that this bull was purchased in Great Britain by a Canadian dealer for a breeder in the United States at a very high price—a price which should have insured an animal in the best condition. The animal arrived at the quarantine station without appetite and suffering alternately from diarrhea and constipation. Either it had been unduly forced and overfed, or the effects of the sea voyage had been unusually severe. However this might be, it did not recover its appetite or condition while at the quarantine station. After it had been in quarantine fourteen days it was tested. At this time it was suffering from constipation. It did not show any unusual symptoms after the injection of the tuberculin, nor did it appear to suffer from it. Two or three days after the tuberculin was injected, and when the effects of the drug could no longer have existed, the attendant gave a purgative to counteract the constipation. This medicine did not have the desired effect, but caused nausea, and evidently frightened the man in charge, who reported the facts to Dr. George W. Pope, superintendent of the station. Dr. Pope did not

consider the bull to be in a serious condition, and gave a simple remedy, which restored the animal to its usual condition of health. The importer and the attendant both appeared to attribute the lack of condition and delicate health of this high-priced animal to the tuberculin test rather than to the real cause.

CONCLUSIONS OF AUTHORITIES ON TUBERCULIN TESTS.

Many persons have in recent years studied the effects of tuberculin as they have been revealed by tests covering vast numbers of animals, and in the present uncertain condition of the public mind in this country on the subject the writer deems it advisable to quote the conclusions of some of the best authorities.

Nocard and Leclainche say:

Direct experiments and observations collected by thousands show that the tuberculin injections have no unfavorable effect. With healthy animals the system is indifferent to the inoculation; with tuberculous animals it causes only slight changes which are not at all serious.¹

Bang has written as follows on this question:²

We will now consider the following question, a very important one in the application of tuberculin, viz: Can the reaction produce a worse condition in tuberculous animals than before existed? Hess emphatically states that it can, and on this account he earnestly warns against its application.³ My attention has been directed to this question from the beginning. In my first publication on tuberculin injection⁴ I reported two cases in which acute miliary tuberculosis was proved in two high-grade tuberculous cows several weeks after the tuberculin injection. I then stated my suspicion that perhaps the tuberculin injection had some connection with this, just as is often supposed to be the case in human practice. With my present very large amount of material for observation at hand I may express the following opinion: Such an acute development of tuberculosis as a result of tuberculin injection is to be feared only exceptionally, and then in cases of advanced tuberculosis. *It must not be forgotten that acute miliary tuberculosis by no means rarely accompanies an advanced tuberculosis of long standing.* It is, therefore, impossible to offer strict proof of the causal connection with the injection, and only oft-repeated observation could make this probable.⁵ In support of my view I offer the following: In the course of the last three years I have made careful post-mortem examinations of 83 tuberculous animals which have been removed from my experiment farm, Thurebylille. Among these were 18 (or strictly speaking 23) high-grade tuberculous animals. I have been able to prove miliary tuberculosis in only 4 of these. Among the others, which showed less developed tuberculosis, I have never found miliary tuberculosis, and with very many I have never found any sign of a more rapid development of the process. On the contrary, it has been proved that the disease was restricted locally, often for years, in spite of yearly repeated injections. Dissections were made at very different periods after the injections—in 17 cases from four to twelve days after the last test. In all of these cases earlier tests had been made months or years

¹ Les Maladies Microbiennes des Animaux, p. 606.

² Bulletin 41, Hatch (Mass.) Experiment Station, 1896, pp. 14-16. Translated from Deutschen Zeitschrift für Tiermedizin und Vergleichende Pathologie, Band XXII.

³ Landwirthschaftl. Jahrbuch, 1894, VII, p. 404.

⁴ Berliner Thieraerztliche Wochenschrift, 1891. Tidskrift för Veterinärer, 1891.

⁵ This view I fully indorse, and do so supported by experience gathered from material forwarded me twice weekly from the Dresden slaughterhouse.—Jöhne.

before. In 28 cases the injection took place from nineteen days to two months before the butchering; in 3 of these cases earlier injections had been made. In 38 cases from two and one-half months to one year intervened between the last injection and the dissection. Dissection gives the best explanation of this question, but a clinical observation, continued for years, of a herd tested with tuberculin can render very essential aid. If Hess's opinion is correct, it is to be assumed that tuberculosis must take an unusually vicious course in such herds, but this I have been unable to prove. At Thurebylille there has existed for three years a reacting division, consisting originally of 131 head and now of 69. Although these animals are yearly tested, and although most of them react every year, the division certainly appears to be made up of healthy animals, and the farm inspector has expressed the decided opinion that the tuberculosis in this division is no more developed than at the beginning of the experiment. The testimony of many owners of large herds of cattle which have long ago been injected is to the same effect. I will adduce statements from several. A farm tenant whose cattle were injected twenty months previously, when 82 per cent of the grown animals reacted, wrote me recently as follows: "Only 2 cows from the division of 100 head had been sold as decidedly tuberculous. The majority appeared afterwards, just as before, entirely healthy. The fat animals which had been slaughtered had been pronounced healthy by the butchers." Another farm tenant with a herd injected in 1894 had not been obliged to remove a single animal from the tuberculous division, numbering 70 head. A large farm owner in Jutland stated in September that he had traced no undesirable result from the injection. His herd of 350 had been injected in February and about 75 per cent reacted. Similar answers have been given by other owners and veterinarians.

A veterinarian who had injected 600 animals, among them a herd of a large farm eighteen months previously, expressed the belief that the injection had produced in no single case an unusually rapid or vicious course of tuberculosis. In spite of a demand made months ago, I have received thus far no report from any veterinarian of an undesirable result.

On a large farm, on which before the injection tuberculosis had appeared in a vicious form, the owner had the impression that the severe cases had afterwards become more numerous. He had, however, not suffered severe losses, and eight months later the large reacting division by no means made a bad impression. Finally, it is to be noticed that tuberculin has been employed on a large scale in Denmark for years, and still the demand from farmers constantly increases. This could certainly not be the case if the injections were generally followed by bad results.

Paige said, after the tests of the herd of the Massachusetts Agricultural College, "that its use is not followed by any ill effects of a serious or permanent nature."¹

Lamson, of the New Hampshire College Agricultural Experiment Station, said: "There is abundant testimony that its use is not in any way injurious to a healthy animal."²

Conn, who made a special study of the present attitude of European science towards tuberculosis in cattle, reached the following conclusions:³

It has been, from the first, thought by some that the use of tuberculin produces a direct injury upon the inoculated animals. This, however, is undoubtedly a mistake, and there is no longer any belief anywhere on the part of scientists that the injury

¹ Bul. No. 27, 1894, p. 22.

² Bul. No. 78, 1900, p. 169.

³ Eleventh Annual Report, Storrs (Conn.) Agl. Exp. Station, 1898, p. 46.

thus produced is worthy of note. In the first place, the idea that it may produce the disease in a perfectly healthy animal by the inoculation is absolutely fallacious. The tuberculin does not contain the tubercle bacillus, and it is absolutely certain that it is impossible to produce a case of tuberculosis in an animal unless the tubercle bacilli are present. The use of tuberculin, therefore, certainly can never produce the disease in the inoculated animal.

It has been more widely believed, however, that the inoculation of an animal with this material has a tendency to stimulate an incipient case of tuberculosis. It has been thought that an animal with a very slight case of the disease may, after inoculation, show a very rapid extension of this disease and be speedily brought to a condition where it is beyond any use. The reasons given for this have been the apparent activity of the tuberculosis infection in animals that have been slaughtered shortly after inoculation. This has been claimed, not only by agriculturists who have not understood the subject well, but also by veterinarians and bacteriologists. But here, too, we must recognize that the claim has been disproved, and that there is now a practical unanimity of opinion on the part of all who are best calculated to judge, that such an injurious effect does not occur. Even those who have been most pronounced in the claim that there is injury thus resulting from tuberculin have, little by little, modified their claim, until at the present time they say either that the injury which they formerly claimed does not occur, or that the stimulus of the disease is so slight that it should be absolutely neglected, in view of the great value which may arise from the use of tuberculin. Apart from two or three who hold this very moderate opinion, all bacteriologists and veterinarians unite in agreeing that there is no evidence for believing that any injury results. In Denmark, especially, many hundreds of thousands of animals have been inoculated, and the veterinarians say there is absolutely no reason in all their experience for believing that the tuberculin inoculation is followed by any injurious results.

In 1898 tuberculosis was found in the large Shorthorn herd belonging to W. C. Edwards, of Canada, who with commendable promptness and public spirit had his animals tested, and at once proceeded to separate the diseased from the healthy animals. These were all finely bred animals, and the very class which we have been told are most susceptible to the injurious effects of tuberculin. After using this test regularly for two years, Mr. Edwards wrote as follows:

I have seen nothing to lead me to believe that the tuberculin test had any injurious influence on the course of the disease. It is by no means our opinion that the disease has been stimulated or aggravated by the application of the tuberculin test. All animals that we have tested two or three times continue as hale and hearty as they were previously, and not one animal in our herds has broken down or failed in any way since we began testing.¹

Mr. Edwards, in December, 1901, verbally stated to the writer that his views as to the harmlessness of tuberculin remained unchanged, and that he had not seen the least ill effect with any of his cattle from its use.

EXPERIENCE OF STATE AUTHORITIES IN SUPPRESSION OF TUBERCULOSIS.

In order to learn the experience and views of the various State authorities engaged in the suppression of tuberculosis by means of the

¹ Tests and Treatment of Tuberculous Cattle, Ottawa, 1900, p. 11.

tuberculin test, inquiries were made of them as to whether any injurious effects had resulted from the use of tuberculin in their work. The replies are summarized as follows:

C. J. Bell, secretary of the Board of Agriculture and Cattle Commission, Vermont: My experience the last four years as one of the cattle commissioners in Vermont leads me to believe there is no injury to healthy cattle by the use of the tuberculin test in sections of the State that are troubled with abortion, and that is in nearly all parts. This trouble is just as likely to occur in sections where herds have never been tested with tuberculin as elsewhere. Since January 1, 1895, some 85,000 or 90,000 head of cattle have been tested in Vermont, and the cattle commissioners serving before me will stand by the statement that up to date we have no reason to believe any healthy cow has been injured by the use of tuberculin. But when cattle are diseased with tuberculosis its use is sometimes injurious.

Dr. Austin Peters, chairman of the Board of Cattle Commissioners, Massachusetts: I do not think tuberculin does any harm to cattle if properly used. I think that cows just on the verge of calving are perhaps not fit subjects for the test, and also think perhaps harm may have been done by the use of syringes that were not properly cleansed, or by tuberculin that had been opened and allowed to stand, or something of that sort; but, ordinarily, I do not think the tuberculin test does any harm to healthy cattle.

In regard to its causing abortion, I suppose that all abortions among cows that have been tested with tuberculin are blamed to the use of this agent; but I doubt if any more abortions occur now than did before it was used. Prior to the use of tuberculin, people had to try and blame something else. I remember an instance, when we had a great deal of infectious abortion in Massachusetts, where a farmer, in Worcester County, had 15 out of 16 cows abort during one winter. If this had been after the discovery of tuberculin, and that herd had been tested with tuberculin the previous autumn, the abortions, of course, would all have been blamed to tuberculin. I think the tuberculin test is used by some farmers and breeders as a scapegoat for all sorts of misfortunes, in many instances where the fault is due to their own lack of care. Many herds of cattle, owned by various farmers, have had tuberculosis introduced among them as the result of buying a pure-bred bull from some breeder; and many of the breeders of pure-bred stock have been breeding tuberculosis as carefully as they have cattle for a great many years.

Since I have been a member of the board (December, 1896) a large number of animals have been tested with tuberculin. In 1896, 8,969 head of neat stock were tested, of which 4,694 were condemned as having tuberculosis. In 1897, 9,991 head were tested and 5,435 were condemned and paid for as tuberculous. In 1898 the legislature thought the commission had been spending too much money, and the board was given a smaller appropriation, and did not do much work, but animals brought into the State from without its limits were still required to be tested with tuberculin, and during the year nearly 27,000 head of cattle for dairy or breeding purposes were brought into Massachusetts. In 1899 about 25,000 head of cattle were brought in from without the State, which were required to be tested with tuberculin, and a few herds were tested at the request of the owners, who wished to eradicate the disease. In the latter way 565 animals were tested, of which 480 were released. During 1900, 21,000 have been brought in from without the State, upon which a tuberculin test has been required, and a few herds have been tested at the request of the owners—291 animals, of which 227 were released. We have had no complaints from any of the owners of injuries to their cattle as a result of the tuberculin test.

Franklin Dye, secretary of Commission on Tuberculosis in Animals, New Jersey: We have the records in our office of about 10,000 tests, in round figures, made during the last year (1900), and have been unable as yet to trace satisfactorily a single

instance where abortion has been produced by using the tuberculin test. There are a few dealers who claim that it is injurious to cattle under some conditions, but this comes from a class who do not like the law, and are opposed to it because it is attended with a little extra work and some expense; but no respectable dealer who is willing to comply with the law, and believes at the same time that the protection it affords is beneficial, makes the least objection. As there is no doubt as to the prevalence of tuberculosis to a very large extent in European countries whence cattle are shipped into our country, we regard the precaution not only good, but an absolute necessity.

Dr. Leonard Pearson, State veterinarian, Pennsylvania: I have made, and have had made under my supervision, about 100,000 tuberculin tests, and I have known of but one instance wherein it was even suspected that tuberculin had the effect of causing abortion. This case is one that occurred recently, wherein two cows aborted in a herd of about 75 members on the day following the test. I do not, however, believe that the test had anything to do with the abortion in this case, and am inclined to ascribe the accident that occurred to causes disassociated with the use of tuberculin. I think I can be very positive on this point, because if tuberculin had any influence whatever in producing abortion it would certainly be apparent in more than two cows out of nearly 100,000.

In the last report of the Pennsylvania department of agriculture letters are given from 446 owners of tested herds. These letters give general information in regard to the results of the inspections that have been made, and also report the condition of the cows following the test. Not one of these 446 herd owners mentions that abortion has occurred, and generally the herds are in better condition than before tuberculin was used.

The three largest owners of dairy cows in the Eastern States are the Fairfield Farm Dairy at Caldwell, N. J., Briarcliff Farms in Westchester County, N. Y., and the Walker-Gordon Laboratory Company, with branches in all of the principal cities. All of the cows added to the herds on these farms are tested with tuberculin, and I have personal knowledge that the herds have been in far better condition since this practice was inaugurated than before. Many of the cows that are purchased for these farms are heavy with calf, and are tested in this condition. Instead of having any influence in the direction of causing abortion this accident occurs less frequently than before the test was used. The owner of one of these herds has told me that the tuberculin test is worth \$2,500 a year to him in keeping his cows in good condition. That is, since he has been using the test none of his cows run down in condition from tuberculosis and have to be sold for a nominal price; on the contrary, they remain in good condition and are sold fat.

In the report of the Pennsylvania department of agriculture for 1898 it was stated that there was no reason whatever to believe that tuberculin ever injured cows, and no reports of suspected injury had been received. Such reports have been solicited, and none have come to my attention with the exception of the one mentioned at the beginning of this letter. It is my experience that the tuberculin test is in greatest demand in those parts of Pennsylvania where it has been used most and is best understood. The use of tuberculin is rapidly increasing in this State. Our laboratory sent out more than 60,000 testing doses of tuberculin last year.

In conclusion, I will say, unreservedly, that I know of no evidence and have no reason to believe that tuberculin has any influence whatever in causing abortion.

C. P. Johnson, secretary State Board of Live Stock Commissioners, Illinois: During the year ending November 1, 1897, this board tested 851 domestic cattle; during the year ending November 1, 1898, 229; during the year ending November 1, 1899, 3,655, and during the year ending November 1, 1900, 2,556—a total of 7,291. There is among all these tests not one authentic case of abortion due to the tuberculin test, and I know of no alleged cases that have any foundation in fact.

From January 1, 1899, to August 7, 1900, there were tested at Union Stock Yards, Chicago, for shipment to points in this State, in round numbers, 7,000 head. The cow brokers, shippers, and dealers, who have used every possible argument that could be trumped up in opposition to the enforcement of these regulations, have maintained that among the imported cattle tested there were frequent cases of abortion which they allege are chargeable to the tuberculin test; but this board is of opinion that the tuberculin test is not responsible for any of these cases of abortion. It stands upon the record of observations made during its four and more years of experience. Among those dairymen in this State who have had their cattle tested annually for a number of years there has never been any complaint whatever from abortion. I am of opinion that an authentic case can not be produced.

Dr. M. H. Reynolds, veterinarian to State Board of Health, Minnesota: Two thousand two hundred and ninety-four cattle have been tested by me personally or under my immediate supervision, and it has been my duty to look over thousands of records in the course of our State work during the past three years. While doing this work nothing has ever occurred which would make it reasonably appear that any of these cows had lost their calves under circumstances that could fairly lead to the conclusion that this trouble was attributable to the tuberculin test.

I think the best evidence bearing on this point that has occurred in the course of my experience with tuberculin is contained in a table published by the Minnesota experiment station (Bulletin No. 51, pages 367-371). The station herd at the time of this test was composed mainly of nervous, sensitive, high-type dairy cows. Anyone at all familiar with this class of cattle ought to understand readily that the herd could not have given practically the same total milk and total butter fat during the week of test as during the week preceding test, if the agent used or any circumstances connected with the test had even moderately disturbed the cows. We have never had an abortion occur in the station herd since the test was introduced here that could be in any way attributed to the tuberculin test, although the test is conducted without any regard to the condition of pregnancy. The only point taken especially into consideration is that the test is probably not quite so reliable during the last week or so of pregnancy.

Dr. J. I. Gibson, State veterinary surgeon, Iowa: There have been tested under my supervision in Iowa upward of 4,000 cows, in all stages of pregnancy, and it has not come to my knowledge that a single cow has aborted apparently as a result of the test applied, which fact warrants me in saying that from my personal knowledge and experience with the test it does not produce abortion, and further, that it is not detrimental to nontuberculous animals.

In my opinion there is absolutely no reason for complaint of injurious effects when the cattle are properly and carefully tested. A rough set of attendants can abuse a herd of cattle a great deal during a test, and when they do the owners charge the ill effects to the action of the tuberculin, which is not in any way responsible, in my judgment.

GENERAL CONCLUSIONS REGARDING THE TUBERCULIN TEST.

Those who have had most experience with tuberculin have, consequently, failed to observe any injurious effects following its use upon healthy cattle. With tuberculous cattle it produces a fever of short duration, and in the great majority of cases all derangement of the system which it causes disappears within forty-eight hours after the tuberculin is administered. There appear to have been a very few cases in which the disease was aggravated, and a greater number in which it was benefited by the injection of tuberculin. The cases of

abortion following the tuberculin test have not been numerous, even when cows were tested within a few weeks of the normal time of calving. The few cases of abortion which have occurred may be explained by the fact that abortion in cattle is a very common occurrence, and that it would inevitably happen sometimes after the tuberculin test as a mere coincidence, and without any relation between the test and the loss of the calf. The cases of abortion which have been cited appear to be no more numerous than might be expected to have occurred among the same number of cattle within the same period if the test had not been applied.

From the investigations and observations that have been mentioned, it may be safely concluded—

(1) That the tuberculin test is a wonderfully accurate method of determining if an animal is affected with tuberculosis.

(2) That by the use of tuberculin the animals diseased with tuberculosis may be detected and removed from the herd, thereby eradicating the disease.

(3) That tuberculin has no injurious effect upon healthy cattle.

(4) That the comparatively small number of cattle which have aborted, suffered in health, or fallen off in condition after the tuberculin test were either diseased before the test was made or were affected by some cause other than the tuberculin.